

Seasonal Mobility and Environmental Stress in an Archaeological Context:  
Analysis of Deer Remains from Three Fort Ancient Sites in Dayton, Ohio

A Senior Honors Thesis

Presented in Partial Fulfillment of the Requirements for graduation  
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by

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## **Abstract**

The SunWatch site was a large Fort Ancient village located in present-day Dayton, Ohio. Much is known about the SunWatch site, but its relationship with smaller Fort Ancient sites in the area remains unclear. This project looks at two smaller sites (Wegerzyn Gardens and Wildcat) to explore that relationship with SunWatch, specifically in terms of seasonal mobility, and to examine the effects of environmental change on deer utilization strategies.

SunWatch was occupied seasonally during its early period (A.D. 1150-1300) and year-round in its later period (A.D. 1300-1450). I examined the Wegerzyn and Wildcat assemblages to see if those sites might be hunting camps from the seasonal period at SunWatch.

A prolonged period of drought in the A.D. 1300s may have had significant consequences for Fort Ancient villages. This study examines deer utilization strategies at these sites through time to see what changes, if any, might be the result of environmental stress.

Seasonality and utilization differences were tested by analyzing all deer bones from radiocarbon-dated contexts at the three sites. White-tailed deer (*Odocoileus virginianus*) was chosen over other species because it is a good proxy for both seasonality and utility and because of its abundance in the sample. The deer remains were aged using epiphyseal closure and tooth eruption sequences. I used meat- and marrow-utility indices to look for differences through time and between small and large sites.

This study was inconclusive with regard to seasonality at the small sites.

The results do imply that deer utilization strategies changed through time, possibly related to environmental stress. Deer age and utility selection practices that are evident in the early period (when environmental conditions were more favorable) are not present in the later period (during a period of increased drought).

## **Acknowledgements**

It has been my privilege to have the support of numerous individuals, without whom this project would have been impossible.

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I must also thank William Kennedy and Lynn Simonelli at the Dayton Society of Natural History. They allowed me to have easy access to the samples in this study and provided data and advice (particularly regarding the Wegerzyn site). Bill and Lynn, through their collaboration with The Ohio State University, also gave me the opportunity to work on the excavations at two of the three sites analyzed in this study.

Many others deserve thanks and I hope I can include them all here. Thanks to Kevin Nolan for sharing his large database of articles and for helping me take this paper from an undergrad paper to a more professional level. Thanks to Dr. Orrin Shane for his advice on the methods of faunal analysis.

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## Introduction

This study compares the way in which deer were utilized at three sites of different sizes and plans and how Fort Ancient peoples responded to environmental stress, specifically drought. Seasonal mobility has been documented at large Fort Ancient villages in southwestern Ohio such as SunWatch, but little attention has been paid to how the many small villages in the area may fit into such a pattern. Additionally, environmental change in the area has been documented, but its effect on Fort Ancient life is unknown. These issues are examined as they are expressed in the remains of white-tailed deer (*Odocoileus virginianus*) at Fort Ancient sites.

### *Fort Ancient*

The last prehistoric culture to inhabit the middle Ohio River Valley was a group of tribal societies collectively referred to as Fort Ancient (Henderson 1998). Fort Ancient occupation in the area spanned from ca. A.D. 1000 to A.D. 1670 (Cowan 1987). Villages were spread along the middle of the Ohio River Valley and its tributaries from southern Indiana in the west to West Virginia in the east, central Ohio in the north, and southern Kentucky in the south (Figure 1).

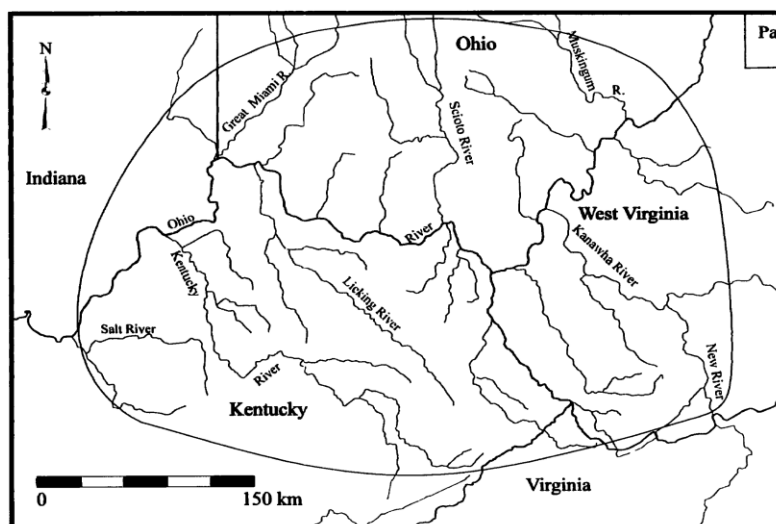


Figure 1. Fort Ancient territory (from Henderson 1998: Figure 2-1)

Fort Ancient has been separated into three temporal phases: Early (ca. A.D. 1000-1200), Middle (ca. A.D. 1200-1400), and Late (ca. A.D. 1400-1670). Like the preceding Late Woodland period, Early Fort Ancient pottery is dominated by jar forms, that often incorporate handles (e.g. strap or lug) and incised rim decorations that are lacking in the Late Woodland pottery. Early Fort Ancient projectile points have a distinct triangular shape with no obvious antecedent in the Late Woodland. Early forms often have convex bases and concave sides (Railey 1992). A typical Early Fort Ancient habitation site was made up of less than ten structures with little evidence of burials or extensive refuse (Henderson 1998).

Henderson described the Middle Fort Ancient as “characterized by variation” (1998:51). There is a general trend toward population nucleation and sites that range from small linear patterns with only a few structures to large circular sites with open plazas and as many as 30 structures. The jar continued as the prevailing pottery form, but other pottery features like shell temper and strap handles gradually increased in frequency (Turnbow 1988; Turnbow and Henderson 1992). Triangular projectile points still dominated, but changed toward straight bases and straight sides (Railey 1992).

The Late Fort Ancient, also known as the Madisonville horizon, continued the Middle Fort Ancient trends of increasing house and village size and the lack of a settlement hierarchy (Henderson 1998). The general pottery forms persisted, but underwent changes specific to the Madisonville horizon. There was an increase in different vessel forms (e.g. bowls, pans, and colanders) as well as in decoration types (e.g. negative painting, effigy rim riders) and surface treatment (e.g. check stamping). Shell temper and the relative amount of decorated pottery sherds also increased (Turnbow and Henderson 1992). Madisonville horizon projectile points retained their triangular form, but more often had concave bases and excurved sides (Railey

1992). Overall, while site size increased, the number of sites decreased and concentrated more around the Ohio River in the Late Fort Ancient (Drooker 1997).

### *Tribal Societies*

Central to this study is the organization of societies deemed by archaeologists to be “tribal.” One of the most important factors that distinguish tribal societies from other social systems is fluidity of social organization (Sahlins 1968). This fluid nature is derived from kinship, which is the basis for tribal organization. Because kinship is innately tied to people who agree, disagree, fight, and make peace, the social organization is influenced primarily by “the dynamic of human agency” (Henderson 1998). This agency and its decentralized power source (kinship) contrast with the more rigidly defined hierarchical structure of chiefdoms. In a practical sense, the fluidity of tribal societies allows them to adapt to immediate situations without creating permanent systems.

### **Study Sites**

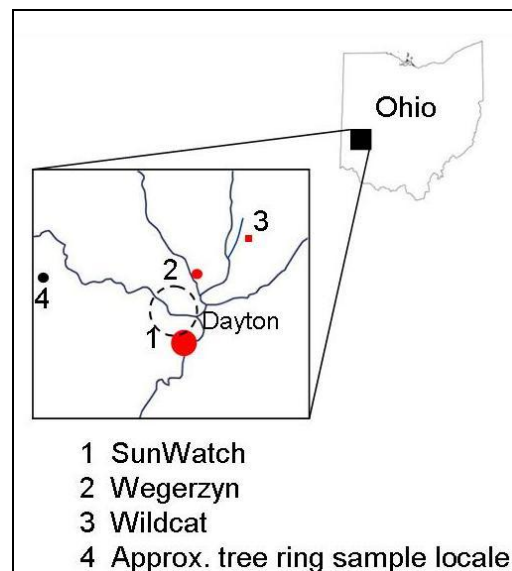


Figure 2. Map of study site locations

## *SunWatch*

The SunWatch site (33My57) is a large (1.4 hectare), circular Fort Ancient habitation site located in what is now Dayton, Ohio. The site sits on the floodplain of the Great Miami River on the Wea Silt Loam soil type (Davis 1976). Like all of the sites in this study, SunWatch lies about 400 kilometers south of the northern limit of the Carolinian Biotic Province and 300 kilometers to the east of its western limit (Shane 1988).

SunWatch is one of the most extensively excavated Fort Ancient sites. The long excavation history began in the 1960s when John Allman and Charles Smith, two avocational archaeologists, excavated in the northeastern part of the village. Their work from 1964-1969 uncovered a range of features including burials, pit features, hearths, and houses. In 1970, J. Heilman, curator of anthropology at the Dayton Society of Natural History (DSNH), found out that the City of Dayton was planning to expand their sewage treatment complex to include the area occupied by the site. With permission from the city, the DSNH began salvage excavations at SunWatch in 1971. In 1975, the site was named on the National Register of Historic Places and the city decided to build elsewhere. From 1975 to 1989, the DSNH excavated every year. Excavations stopped in 1989 when the museum and interpretive center opened. The only significant excavations since that time took place in 2005 when crews from The Ohio State University and the DSNH reexamined the northeast part of the village and tested the unexcavated eastern side of the circular settlement (Cook 2008).

The results of over 30 years of excavation have revealed a very detailed picture of life at SunWatch (Figure 3). The site probably consists of either one long (10-30 years) occupation between the late A.D. 1200s and early A.D. 1300s or two short (5-15 years) occupations: one in



the late A.D. 1100s and one in the late A.D. 1300s (Cook 2007). In either case, it appears that the site had two distinct phases.

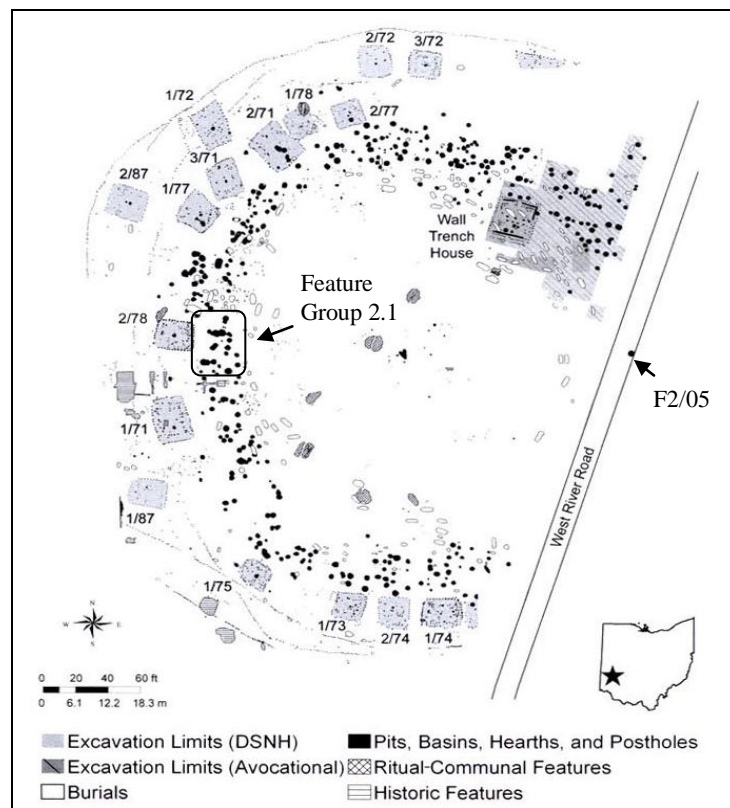


Figure 3. Map of excavations and features at SunWatch (from Cook 2007: Figure 1)

In the early phase (Cook 2007), the site was occupied during the warm seasons, with winters being spent away at hunting camps (Shane 1988; Wagner 1996). This period was also characterized by corporate leadership where family groups held influence over their small sections in the village circle (Cook 2008). The later phase coincides with an increased Middle Mississippian influence in the village with the construction of a wall-trench house (Cook 2008). Amongst other changes, this phase saw the site occupied year-round and saw leadership develop on a village-wide scale (Cook 2008).

## *Wegerzyn*

The Wegerzyn Gardens Center site (33My127; referred to as Wegerzyn in this study) is a 0.3 hectare site located along the Stillwater River in Dayton, Ohio a little more than 10.5 kilometers (6.5 miles) straight-line distance, north of SunWatch. The site is situated within the Carolinian Biotic Province on the Ross Silt Loam soil type (Davis 1976). The mean radiocarbon dates place occupation of this site between A.D. 1080 and A.D. 1380. It is notable that the two earliest dates (at A.D. 1080) are the two with the largest error ranges and are not spatially near one another. That has led to the conclusion that occupation probably did not begin until at least the A.D. 1200s (still within the error ranges for the two early dates) with the main occupation in the A.D. 1300s (Simonelli and Kennedy 2003).

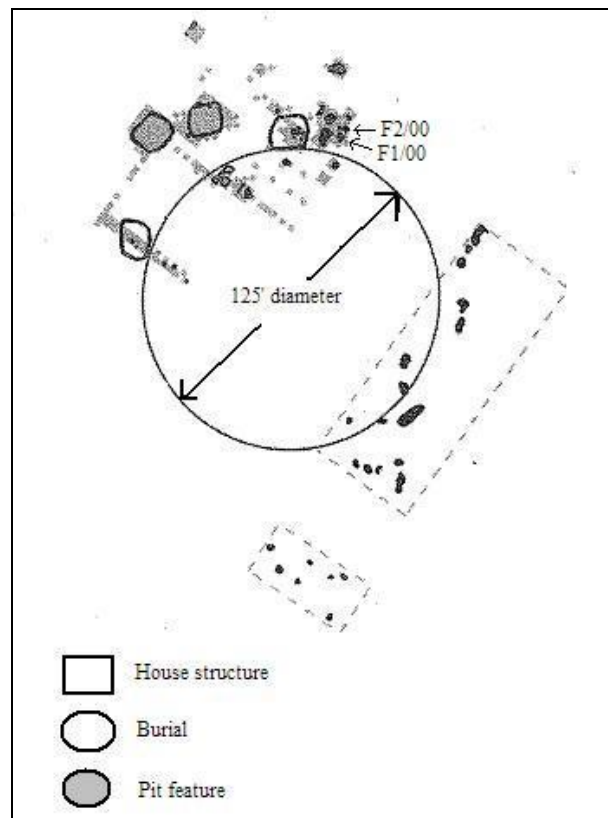


Figure 4. Map of excavations at Wegerzyn (from Cook 2008: Figure 6.5)

Excavations at Wegerzyn began in the early 1990s by the DSNH shortly after regular excavations ceased at SunWatch. Continuous excavation each summer since has revealed an arc of structures that could represent the northern part of a circular village plan (Figure 4). The site appears to be similar in plan to other small circular Fort Ancient villages like Horseshoe Johnson (Hawkins 1998) and Carpenter Farm (Pollack and Hockensmith 1992). Horseshoe Johnson contains similar features to SunWatch such as single-post construction of houses and an empty plaza ringed by trash pits, but half the diameter of SunWatch (see Cook 2008). In this study, Wegerzyn represents this group of smaller, circular Fort Ancient villages.

### *Wildcat*

The Wildcat site (33My499) is located north of both SunWatch (ca. 18 km) and Wegerzyn (ca. 8.5 km). Wildcat is distinct because of its distance from the nearest major river. While SunWatch sits 0.25 km from the Miami River and Wegerzyn sits 0.16 km from the Stillwater River (directly on the river for all practical purposes), Wildcat sits near a small intermittent stream, 1.7 km from the Miami River.

The Wildcat site has a very short excavation history. Intensive academic investigations by The Ohio State University have gone on for one five-week field season in 2007. However, these excavations, combined with a month of intensive magnetometry survey, indicate that the village probably had a linear plan covering about 0.3 hectares (Cook and Burks, personal communication 2008: Figure 5). In Fort Ancient contexts, this type of plan consists of fewer houses than the circular, palisaded villages like SunWatch. Results so far have shown a pattern similar to the Killen-Grimes site farther to the south in Adams County, Ohio (Brose 1982) and the Van Meter site in Kentucky (Railey 1985).

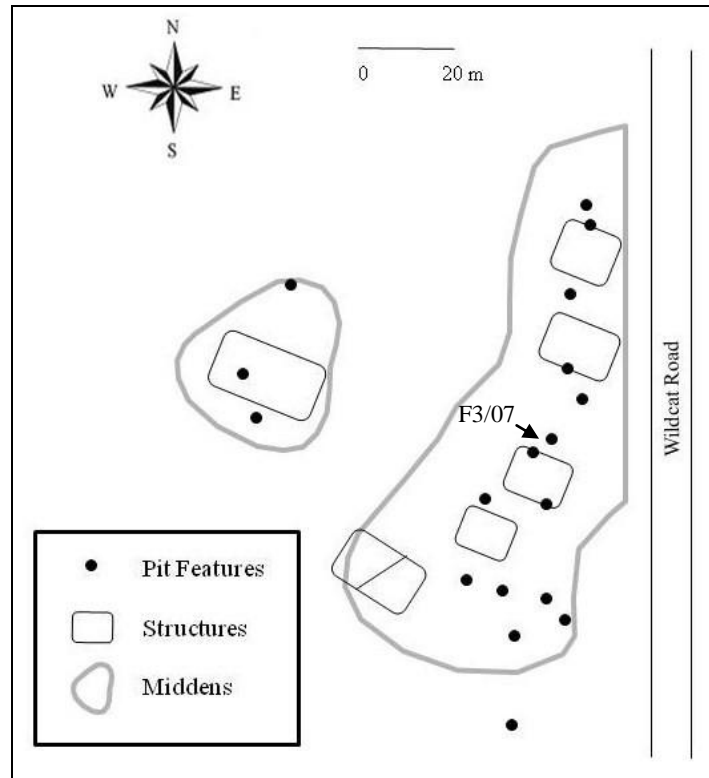


Figure 5. Preliminary interpretation of Wildcat excavations (map courtesy of Robert Cook)

## Site Relationship Models

### *Seasonal Mobility*

One way to model the relationship between sites would be a pattern of seasonal mobility. Seasonal mobility is well-documented in numerous anthropological cases and partial seasonal abandonment has been suggested for SunWatch on the basis of plant remains (Wagner 1996) and deer remains (Shane 1988). Seasonal systems usually consist of a group of villagers leaving the home base village for a portion of the year to participate in hunting, gathering, or a combination of the two. They may establish small villages to act as temporary bases for their hunting and gathering activities. In the event that some villagers stayed behind at the home base, the camp may supply them with the products of the hunt or the fruits of the harvest. In this study, I will

only examine the presence or absence of hunting camp behavior at Wegerzyn and Wildcat (in relation to the home base behavior at SunWatch). Hunting camp behavior patterns often leave a distinct archaeological signature. When high-utility cuts of meat are transported back to the home base, an abundance of low-utility elements are left at the camp and subsequently become part of the archaeological record.

First, the seasonal mobility model will be tested by aging the deer bones and teeth to look for any indication that the deer were only hunted during part of the year. Second, I will test to see if the element counts correlate with the utility values for those elements. A strong negative correlation at the smaller surrounding sites would indicate that they are selectively removing the high-utility elements from the site and, presumably, transporting them to SunWatch.

### *Environmental Stress*

A second model for differences in deer utilization is related to environmental change. In this model, utilization differences may be a reflection of a change in environment that forces people to change their behavior patterns. Cook et al. (1999, 2004) compiled data from tree rings across North America that showed the amount of summer precipitation in each year. They compared tree ring width with the Palmer Drought Severity Index (PDSI) to examine drought in North America over the last 2,000 years. Relevant to this study, Cook et al. (1999, 2004) found that between about A.D. 1325 and A.D. 1400, southwestern Ohio experienced some of the worst drought years of the past 1,000 years in the area (Figure 6).

Drought of this length and magnitude would have had serious consequences for Fort Ancient villages and their increasing reliance on agriculture. Radiocarbon dates place three of the pit features in this study (SunWatch Feature 2/05, Wegerzyn Feature 1/00, and Wildcat Feature 3/07) before the drought and one pit feature (Wegerzyn Feature 2/00) during the drought

years. Data from Pit Feature Group 2.1 at SunWatch has also been included to represent the faunal assemblage at SunWatch during the drought years. Though lacking a radiocarbon date, diagnostic pit feature and artifact attribute concentrations place Pit Feature Group 2.1 in the later stage (ca. A.D. 1350-1400) of SunWatch occupation (Cook, personal communication 2007).

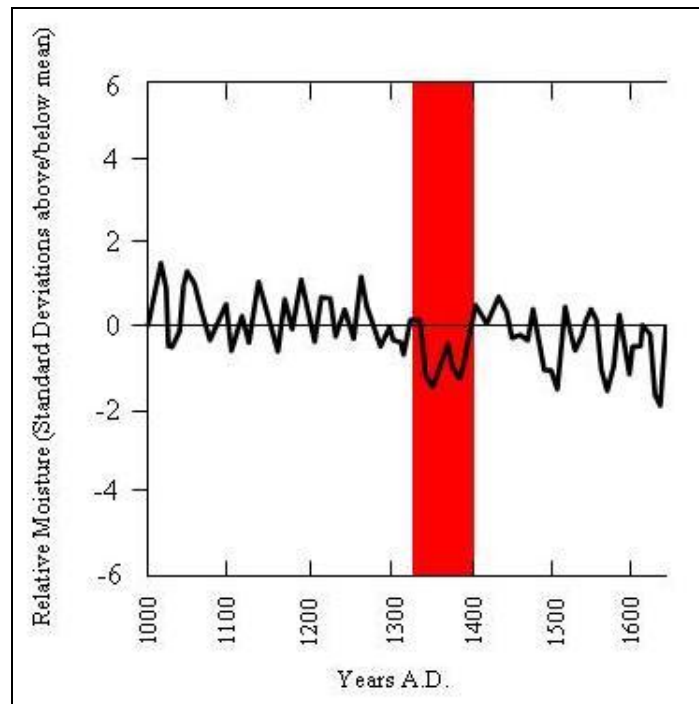


Figure 6. Relative moisture from tree rings (adapted from Cook et al. (1999, 2004)). Data derived from location 4 in Figure 2.

These four samples allow me to compare changes in site relationships through time. In this case, I compare the relationships pre-drought (SunWatch [Feature 2/05] and Wildcat [Feature 3/07]) and during the drought (SunWatch [Pit Feature Group 2.1] and Wegerzyn [Feature 2/00]) to see how Fort Ancient villages reacted to the environmental stress.

Drought stress would cause pressure from two directions, both of which should show up in the archaeological record. First, drought would lower the availability of plant resources, both domestic and wild, that were a major part of Fort Ancient diet. This would force villagers to rely

more on meat from hunting. They would not have the luxury of selectivity with regard to deer age and utility (as they may have in the past) because they would now have to maximize for total meat, rather than efficiency or quality. Any deer population management strategies, such as avoiding young deer, would likely be abandoned (Bousman 2005). As a result, more juvenile deer would be hunted because they represent the most abundant group in the wild population. At the same time, a decrease in available plant resources (due to drought) will negatively impact the available deer population (Ozoga and Verme 1982). Lacking the same amount of plant resources, deer would decrease in average body size and would suffer a decrease in fertility. Female white-tailed deer (does) are capable of breeding in their first year, but only under optimal environmental conditions (Hesselton and Hesselton 1982). If the environmental conditions are not favorable, does will not bear children that first year, thereby reducing the number of births per year and, subsequently, the total wild population. In summary, villagers would be forced to hunt more young deer, but there would be even fewer young deer available because the deer population would also suffer from environmental stress. One would expect to see this shift to young deer archaeologically through an increase in juvenile remains. Additionally, one would expect to see a general drop in utility related to a decrease in selectivity on the basis of utility.

Another possible reaction is that environmental change caused people to group together in an effort to pool resources. This kind of activity would effectively buffer them against food stress that can be caused by environmental change (Kelly 1995). One way to create a buffer would be through the growth of a heterarchical relationship. Heterarchy is a term used to describe a situation when certain villages had a temporary or fluctuating element of influence over others without the development of a ranked (or hierarchical) system (Ehrenreich et. al. 1995). A village with limited resources may need assistance from its larger, better organized

neighbor and so would grant the neighbor a temporary degree of control in the relationship between the villages in exchange for security (in this case, food security). A similar question about site relationships was investigated by Henderson (1998). She examined site relationships for Fort Ancient villages in central Kentucky. Henderson concluded that the relationship there was heterarchical with “evidence for disjunctive ranking reflecting situational expression of inequality” (1998:502).

A system of heterarchy has also been suggested previously for Fort Ancient social organization in southwest Ohio. Cook suggested a heterarchy in a discussion of SunWatch (2008). Simonelli and Kennedy (2003) suggested a heterarchical system in a comparison between Wegerzyn and SunWatch by identifying (according to Henderson’s criteria) variety in village size, a common tradition of material culture (with some variation), and more “modest” (though still similar) burial practices at Wegerzyn.

Archaeofaunal data can reflect a heterarchical relationship in that it can depict the pooling of resources that would occur if deer were being shared. In a heterarchy, SunWatch, as the large local center, could have integrated the surrounding smaller villages into its sphere to facilitate resource sharing. This would have buffered both parties against food shortages. This relationship would be reflected in the record by a pattern of supply where smaller villages would supply better cuts of meat to SunWatch. This pattern is similar to the one we would expect for a seasonal hunting camp, but would instead be occupied year-round by a population separate from SunWatch.



## Methodology

### *Sampling*

The sample included all of the white-tailed deer (*Odocoileus virginianus*) bones from Feature 2/05 and Pit Feature Group 2.1 at SunWatch, Features 1/00 and 2/00 at Wegerzyn, and Feature 3/07 at Wildcat. All of these features are trash pit features. This project was limited to deer bones for two reasons. First, deer are by far the most abundant species represented at all three sites, thus providing a large sample. Second, deer bones have the ability to inform on both of the study issues: seasonality and responses to environmental stress.

In this study, it was assumed that all deer bones in the sample were the result of human harvest and that nearly all of the deer were harvested for food rather than for tool making or ceremonial purposes. Deer bone tools are present at all three sites, but they are not frequent enough to suggest that deer were hunted only for their tool potential rather than their meat potential.

The four pit features analyzed in this study have been radiocarbon dated, allowing examination of changes in hunting practices over time as well as by site organization. SunWatch Feature 2/05 has a mean calibrated AMS radiocarbon date of A.D. 1289 (Cook 2007:446). From Wegerzyn, Feature 1/00 has a mean radiometric date of A.D. 1245 and Feature 2/00 has a mean calibrated AMS radiocarbon date of A.D. 1380. Feature 3/07 at Wildcat has a mean calibrated AMS radiocarbon date of A.D. 1272. The date from Feature 2/00 at Wegerzyn is especially important because it falls after the environment began to change around A.D. 1300.

### *Taphonomy*

It is important in any faunal study to consider the taphonomic processes at work on a site, but it is especially important when utility is a concern. Lyman (1985) provided an excellent

discussion of the problems relating to utility and taphonomy. One major issue Lyman cited was that there is some negative correlation between utility and density of bone. That is, high-utility bones commonly have low densities, making them less likely to preserve. Lyman noted that differential transportation practices (i.e. selecting for high-utility parts) have the same effect on the archaeological record as post-depositional destructive forces. In short, both forces change the frequencies of skeletal elements, resulting in identical profiles for utility but for different reasons. This equifinality has also been addressed by Rogers (2000), who cited carnivores and acidic soils as major agents of decay. Carnivores are not a major factor in southwestern Ohio; there are no large bone-accumulating animals like jaguars. Additionally, the bones in the sample are all from trash pit contexts, indicating that they were deposited directly by humans. Soil acidity, however, does deserve consideration. Highly acidic soils preferentially destroy the smaller, less dense bones which could bias the sample towards the larger, denser bones and skew the utility measures.

The soils in the study area range in pH from 7.0 to 8.0, excellent conditions for preservation (Shane 1988; Davis et al. 1976). Anecdotal evidence also supports the conclusion that preservation was similar at all three sites. The presence of very small bones from rodents, fish, and birds also indicates that preservation was excellent and not skewed toward the densest bones. This ensures that any differences in utility or frequency were likely the result of human activities and not of differential preservation. Therefore, for this study, equal preservation of animal bones at SunWatch, Wegerzyn, and Wildcat can be assumed.

### *Identification*

The bones from Pit Feature Group 2.1 were identified by Dr. Orrin Shane according the methodology discussed in Shane (1988). Dr. Shane also initially identified the bones from

SunWatch Feature 2/05, but here I reexamined and recorded them according to my methodology. That being said, my methodology was shaped by conversations with Dr. Shane and there is no reason to believe our methods differ in any significant way.

The first step in the identification process was to separate the mammal bones from the bones of fish, birds, reptiles, and amphibians. Bird bones are usually very small, light, and nearly hollow through the mid-shaft. Fish bone is laid down in layers, which gives it a striated appearance. These special features were the basis for distinguishing between mammal bone and other animals. Once the bone was identified as mammal, its size was judged to determine if it was deer. Deer are one of the largest mammals in the Eastern Woodlands (Hesselton and Hesselton 1982) and there is a large difference in size between deer and the next smallest mammal, the dog, so it is easy to differentiate between the two. If the bone was incomplete, thickness and general robustness were used as a proxy of size. This method is subject to misidentification of similar-sized bones. For example, elk bones can be confused with deer bones, but elk are not exceptionally abundant in Fort Ancient assemblages.

After the bones were identified as deer bones, they were identified to skeletal element, side, and completeness (proximal, medial, distal, or complete) using standard osteological reference materials (Gilbert 1980; Olsen 1964). Bones were deemed identifiable if they had an articular surface or a unique morphological feature such as the deep anterior medial groove on the metapodials. Any bones that were unfused, burned, gnawed, or had cut marks were noted as such. Deer bones that were unidentified after looking at the reference materials were taken to The Ohio State University Department of Anthropology and identified using a comparative collection of white-tailed and black-tailed deer. Identifications and observations were recorded by hand and later entered into a Microsoft Excel database.

### *NISP and MNI*

Number of identified specimens (NISP) was calculated by counting the number of bones identified to each element (Payne 1975).

Minimum number of individuals (MNI) required a more methodical approach. An MNI for each element was determined by first counting the number of lefts and rights. For paired bones, the larger number was the preliminary MNI. Bones not identified to a side were summed and divided by the number of that element in the skeleton. This number was added to the preliminary MNI to get actual MNI for that element. For example, in SunWatch's Feature 2/05, there are 7 right and 6 left humerii, which gives us a preliminary MNI of 7. There are also 10 unsided humerii. Dividing that count by two (because there are two humerii in one individual) gives us an extra 5 for the MNI for a total of 12. It is important to note that this method assumes that prehistoric people were not selecting for a particular side of the animal. The counts for the sided elements are fairly balanced between right and left, so there is no indication that one side was preferred to the other. For a more detailed discussion of this method for determining MNI, see Klein and Cruz-Urbe (1984:26).

A consideration of the nature of the sample forced a slight revision of this method. There were difficulties calculating MNI due to the high number of unfused bones, especially for the Wegerzyn sample. Matching was not an option due to logistical reasons so I have used the MNI calculated for the astragalus. The astragalus was chosen because, unlike the long bones, it is not subject to problems of fusion and, unlike other non-long bones, its dense block-like form preserves very well.

### *Deer Utility*

Two utility indices are used in this study. The first was developed and explained by Madrigal and Zimmermann Holt (2002). Their study examined the potential meat and marrow utilities of white-tailed deer in the Eastern Woodlands and so was appropriate to apply to this sample. Their meat and marrow utility indices are defined by the number of kilocalories available from each cut of meat. Because each cut does not directly correspond to a skeletal element, each cut was assigned to an element. Also included were measures of the meat and marrow return rates (kilocalories per hour) for each element to help indicate which cuts are the most efficient to harvest. These indices will be used to check for differences in site function, especially the presence of a hunting camp pattern of behavior.

Also included is a food utility index (see Metcalfe and Jones 1988; Purdue et al. 1989) to compare utility patterns across sites. Bones were grouped according their utility value (i.e. low, medium, or high) and the relative abundances (based on NISP) were compared.

### *Aging Techniques*

Two methods of aging the deer were used. The first is based on the tooth wear; the second is based on the rate of epiphyseal fusion.

Tooth wear data were collected in two ways. For the SunWatch and Wildcat samples, crown heights for the teeth in the sample were used to help develop an age profile following Severinghaus (1949). First, heights were only recorded for mandibular teeth. The height above the gum line was measured to the hundredth of a millimeter using Mitutoyo brand digital calipers. For teeth with multiple crests (i.e. molars), the heights of all crests were measured and averaged. In the case of the third molar and its three cusps, only the two anterior crests were

measured. The crown heights were compared with Severinghaus' (1949:Table 2) standard and assigned an age range.

Some teeth were still part of the mandible. In these cases, the tooth crown height was measured for each tooth and an age was assigned to each tooth. The average of these ages represents the estimated age for that individual. Because Severinghaus used ranges to define some of the stages (e.g. "13-17 months"), it was necessary to average these before averaging all the teeth in the mandible. For example, I changed a range of 13-17 months to 15 months for calculation purposes.

The teeth in the Wegerzyn sample were aged based on a comparative series of mandible molds of known ages manufactured by Wildlife Enterprises of Kerrville, Texas. The mandibles are arranged in one year increments starting at six months. If a mandible in the sample did not strongly resemble one of the wear patterns present (six months, 1.5 years, 2.5 years, etc.) I assigned it to the whole year between the two closest matches. For example, a mandible with wear falling somewhere between 2.5 and 3.5 years was assigned an age of 3 years.

The Severinghaus method was not used for the Wegerzyn teeth. Severinghaus presented only averages (not ranges) for each age class and since many of my values (13.6, for example) fell far above his highest average value (10.5 mm), there was doubt about how to interpret my lower values; they could also be inflated. Instead, the comparative method was used because wear in this sense should be the same regardless of something like tooth size which has a genetic component. Because there were different methodologies for the samples, an effort was made to limit intersite comparison based on tooth wear criteria. When it is used, broad categories such as "juvenile" and "adult" that do not rely on highly specific ages are referred to.

Deer bones were also aged using the rate of epiphyseal fusion, applying the standards presented in Purdue (1983) to estimate an age for each unfused bone. These ages are all maximum ages which could represent deer of any age up to the time when the bone fuses. Epiphyseal fusion data are often presented in this study as simply the proportion of unfused to fused bones in each sample.

## **Results**

### *NISP and MNI*

The samples from all three sites were large enough to yield high NISPs. At SunWatch, Feature 2/05 contained 427 identifiable deer bones and Pit Feature Group 2.1 contained 631. Feature 3/07 from Wildcat had a NISP of 202. Wegerzyn had a NISP of 1,148; 96 from Feature 1/00 and 1,052 from Feature 2/00.

Using the astragalus (see above for explanation), the minimum number of individuals (MNI) represented in the SunWatch F2/05 sample is 6. At Wildcat, it is 6 as well. Wegerzyn has a MNI of 12. The MNI in SunWatch Pit Feature Group 2.1 is 10.

### *Utility*

Although long bone MNI was deemed problematic for assigning an MNI to each sample, it was used to look for patterns in utility similar to Madrigal and Zimmerman Holt (2002), testing for a correlation between MNIs and meat yield. A positive correlation would mean that villagers employed a deer harvesting strategy that was based on the amount of meat available. None of the sites were significant with respect to meat yield. The same procedure was applied to compare MNIs to meat return rate (in kilocalories per hour), marrow yield, and marrow return

rate (in kilocalories per hour). Again, none of these measures correlated significantly with MNI at any of the three sites (Table 1).

r	Meat Yield	Meat Return Rate	Marrow Yield	Marrow Return Rate
Wildcat	-0.0381	-0.2047	0.3181	0.3995
SunWatch	0.2708	-0.2112	-0.0045	0.3492
Wegerzyn	-0.4429	-0.3886	0.0296	0.0466

Table 1. R-values for meat and marrow utility profiles

This does not, however, rule out utility as a useful component because it does not address intersite differences. In fact, there are some strong differences between the sites in the relative abundances of high and low utility elements.

To compare the utility across sites, elements were aggregated based on ten general parts of the skeleton: head, shoulder, upper forelimb, middle forelimb, lower forelimb, midsection, hip area, upper hindlimb, middle hindlimb, and lower hindlimb. The relative frequencies of the elements that made up each of these areas were totaled. This allowed intersite differences in the general patterns of utility to be assessed (Figure 7).

The strongest differences exist between the early SunWatch feature and the other three samples. Ribs and thoracic vertebrae make up 38.4% of the SunWatch Feature 2/05 sample. At Wildcat, Wegerzyn, and late SunWatch, they account for 19.81%, 17.94% and 11.09% of the sample, respectively. This is important because ribs and thoracic vertebrae are two of the three most useful elements in terms of meat yield. In the same vein, low utility elements from the lower legs are much more abundant at the smaller sites. These parts have so little meat value that Madrigal and Zimmerman Holt (2002) did not give them a value.



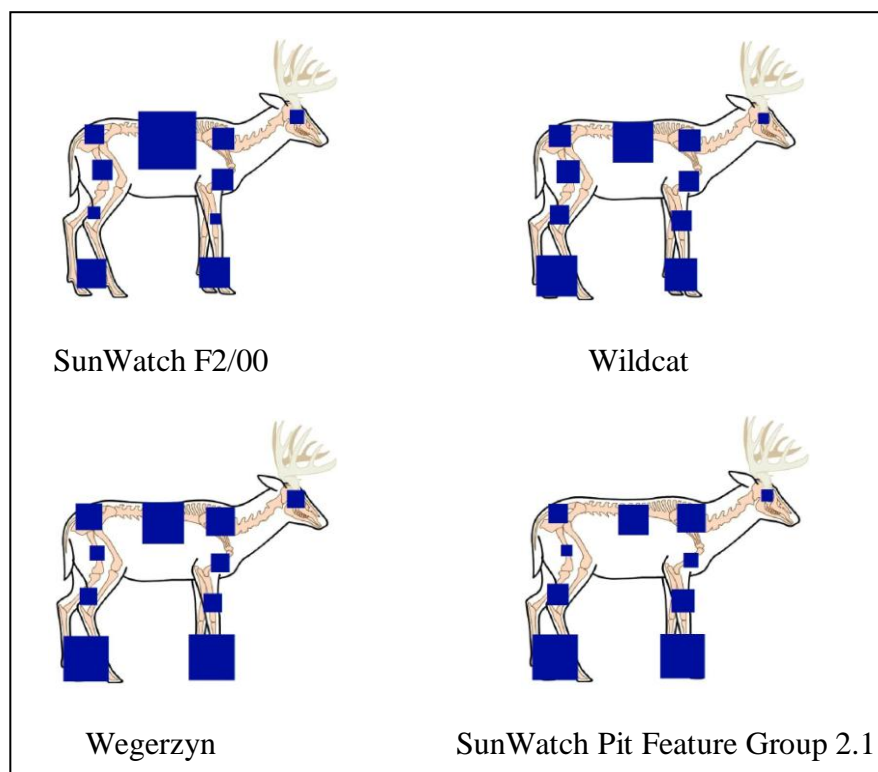


Figure 7. Meat utility by skeletal area

Another important distinction is the low frequency of femora at Wegerzyn and late SunWatch. Femora are high in utility for both meat and marrow. However, at Wegerzyn and late SunWatch, femora account for only 2.25% and 1.58% of the sample, respectively, compared to 4.68% at early SunWatch and 6.44% at Wildcat.

r	Wildcat	SunWatch	Wegerzyn	SunWatch2
Wildcat	1	0.762	0.897	0.777
SunWatch	0.762	1	0.613	0.319
Wegerzyn	0.897	0.613	1	0.928
SunWatch2	0.777	0.319	0.928	1

Table 2. Correlation matrix of meat utility by skeletal area

Of the four patterns (Wildcat, early SunWatch, Wegerzyn, and late SunWatch) only the pattern seen at Wegerzyn and the pattern from Pit Feature Group 2.1, or late SunWatch, have a strong correlation (Table 2). The implications of this correlation are discussed later.

The food utility index shows a similar pattern (Tables 3 and 4). The two early samples are very similar ( $r=0.985$ ) to each other as are the two later samples ( $r=0.969$ ). However, there is not a strong correlation between any of the early and late samples. It is also worth noting that there is a very strong correlation between each of the late samples and the pattern that we would expect in a complete deer skeleton ( $r=0.987$  for Wegerzyn;  $r=0.996$  for late SunWatch). Again, this correlation will be discussed later.

<b>Food Utility Index</b>					
	Wildcat	SunWatch1	Wegerzyn	SunWatch2	Complete Deer
Skull	1.03%	0.00%	1.17%	1.75%	9.80%
Mandible	0.51%	2.42%	1.71%	0.00%	1.40%
Atlas+Axis	1.03%	0.24%	1.99%	1.91%	1.40%
Metacarpal +Carpals	8.21%	7.73%	12.14%	11.48%	11.20%
Phalanges	11.79%	14.25%	20.49%	24.88%	16.80%
<b>Total Low</b>	<b>22.56%</b>	<b>24.64%</b>	<b>37.50%</b>	<b>40.03%</b>	<b>40.60%</b>
Vertebrae	13.85%	20.29%	17.42%	12.92%	16.80%
Pelvis+Sacrum	2.05%	2.90%	1.71%	1.91%	2.10%
Ribs	13.85%	22.71%	11.82%	4.78%	16.80%
Scapula	2.56%	3.62%	2.08%	3.99%	1.40%
Humerus	5.13%	5.56%	3.70%	2.71%	2.80%
Radius/ulna	5.13%	1.45%	3.70%	6.54%	2.80%
Metatarsal	14.87%	6.52%	7.18%	8.61%	2.80%
<b>Total Medium</b>	<b>57.44%</b>	<b>63.04%</b>	<b>47.61%</b>	<b>41.47%</b>	<b>45.50%</b>
Femur	6.67%	4.83%	2.44%	1.59%	2.80%
Tibia+Tarsals	13.33%	7.49%	12.45%	16.91%	11.20%
<b>Total High</b>	<b>20.00%</b>	<b>12.32%</b>	<b>14.89%</b>	<b>18.50%</b>	<b>14.00%</b>

Table 3. Food utility values

r	Wildcat	SunWatch	Wegerzyn	SunWatch2	Complete Deer
Wildcat	1	0.985	0.778	0.598	0.667
SunWatch	0.985	1	0.875	0.727	0.786
Wegerzyn	0.778	0.875	1	0.969	0.987
SunWatch2	0.598	0.727	0.969	1	0.996
Complete Deer	0.667	0.786	0.987	0.996	1

Table 4. Correlation matrix of food utility patterns

### *Tooth Wear*

The tooth wear data have revealed two patterns (Figure 8). One pattern, present at SunWatch, includes deer of varying ages. The SunWatch sample contained teeth from six individuals, five of which were mandibles with multiple teeth present. In these cases, an age was determined for each tooth based on the Severinghaus (1949) standard, then the teeth were averaged to determine the age for that mandible. Two of the deer represented are juveniles and four are adults. Although this sample is not large enough to construct a detailed age profile for the hunted population, the pattern of taking some young, some old, but mostly prime age adults indicates that hunters from SunWatch may have preferred to harvest deer with the most meat available. This pattern was also recognized for other pits at SunWatch (Shane 1988) and for other contemporary Mississippian peoples (Smith 1975).

The second pattern is one with a focus on young deer. At Wildcat, all four individuals represented are juveniles. The Wegerzyn sample contains eight juveniles (less than two years old) and seven adults ranging from two to seven years old. Since male white-tailed deer reach maximum size between four and five years and female white-tailed deer reach maximum size between three and four years (Hesselton and Hesselton 1982), focusing on juvenile deer would not have yielded the maximum amount of meat.

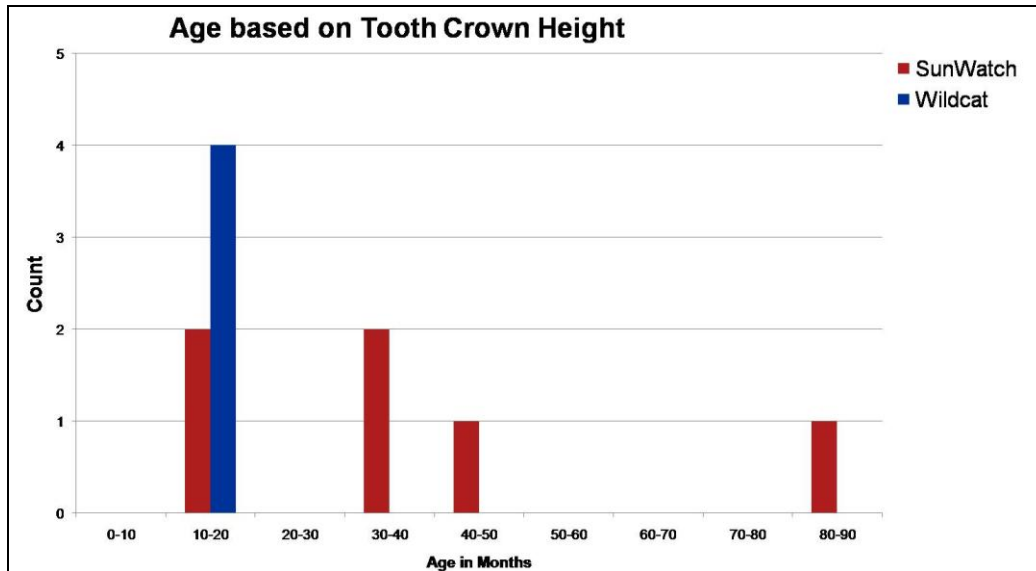


Figure 8. Age based on tooth crown height for SunWatch F2/05 (early) and Wildcat

### *Epiphyseal Fusion*

The results of the epiphyseal fusion analysis support the conclusions from the tooth wear analysis. Again, two patterns were revealed (Figure 9). The patterns are best expressed by examining the number of unfused bones relative to the total number of bones in the sample. Of the 427 bones in the SunWatch Feature 2/05 sample, only 22 are unfused. This amounts to 5.15% of the sample. This echoes the tooth wear analysis that indicated adult deer were the priority. This value gains more meaning when contrasted with the patterns at the Wildcat and Wegerzyn sites.

The Wildcat sample contains 202 identified deer bones, 25 of which are unfused. This amounts to 12.38% of the sample. That is almost two and a half times more than the number of unfused bones from SunWatch, a significant difference ( $p=0.001295$ ). Again, this supports the conclusion that the four individuals in the Wildcat tooth wear analysis were all juveniles.

The Wegerzyn sample is the most extreme in terms of unfused bones. A total of 247 of the 1,148 deer bones are unfused. That is 21.52% of the sample. That is more than four times greater than the value for SunWatch and over one and a half times greater than even the Wildcat sample, both of which are statistically significant ( $p < 0.0001$  and  $p = 0.002821$ , respectively).

In SunWatch Pit Feature Group 2.1, 112 of the 631 bones are unfused bones, 17.75% of the sample. When compared to the earlier SunWatch feature (5.15%), Pit Feature Group 2.1 has a statistically significant increase in juvenile bones ( $p < 0.0001$ ).

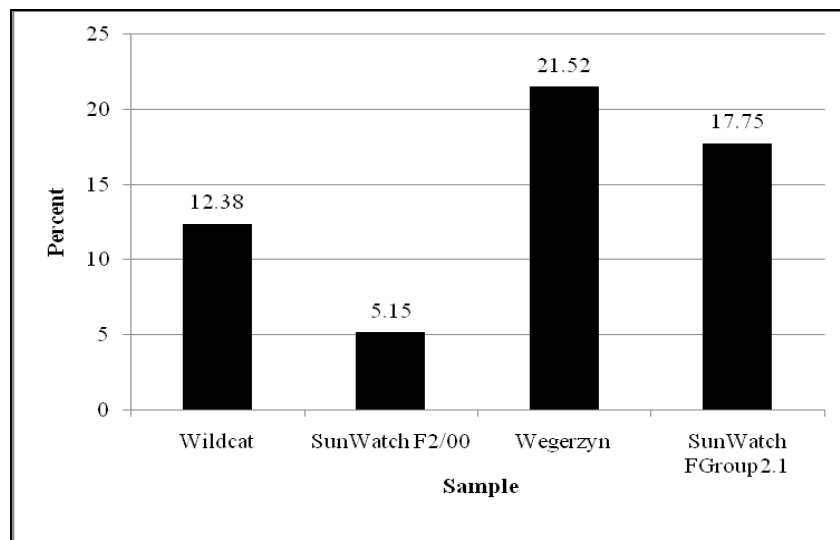


Figure 9. Relative abundances of juvenile bones

None of the three sites facilitated a definite determination of seasonality. The sites analyzed for tooth wear did not provide enough individuals (six at SunWatch, four at Wildcat) to reconstruct a detailed age profile of the hunted population. The epiphyseal fusion aging method did provide large samples, but it did not provide the requisite resolution needed to assign a month-at-death to each individual. However, the presence of individuals less than five months (based on unfused proximal radii) could indicate a warm season occupation at Wildcat and

Wegerzyn. Because white-tailed deer are born in late May or early June (Hesselton and Hesselton 1982), a maximum age of five months for those individuals would place their death around late October or early November, the beginning of the cold season. However, these individuals could be anywhere between zero and five months, so there is a possibility that their death could have occurred much earlier in the year during the warm months.

## **Discussion and Conclusions**

In this study, samples from three Fort Ancient sites were examined to reconstruct possible relationships between the sites. Three models of relationships were proposed: seasonal mobility/hunting camps, uniform decline due to environmental stress, and situational heterarchy as a buffer to environmental stress. I will now discuss the validity of each model as it applies to this faunal sample.

### *Seasonal Mobility*

Seasonal mobility was proposed in the past by Wagner (1996) and Shane (1988) because of evidence of partial seasonal abandonment at SunWatch. However, no evidence was present to indicate that Wildcat and Wegerzyn were seasonal hunting camps. With sample sizes for tooth wear too small to construct a detailed age profile, other measures for seasonal hunting camps were utilized. Unfused proximal radii belonging to individuals less than 5 months old raise the possibility of warm month kills, but this evidence should not be construed as definitive.

Yerkes (2005:Figure 4) identified a pattern of animal class abundance related to seasonal pit use in Mississippian pits at the Aztalan site. In the fall and winter, mammals (mostly deer) dominate, followed distantly by birds then fish. In the spring/summer, fish dominate, followed by mammals. In the late summer, reptiles and amphibians are the most abundant, followed

closely by fish, gastropods, and mammals. Relative abundance data for non-deer are unavailable for these samples, but based on my initial classification of mammal vs. non-mammal, anecdotal evidence suggests that Wildcat and Wegerzyn are dominated by deer bones with small mammal bones the next most abundant. According to Yerkes's pattern, this suggests that these pits were filled in the fall or winter. Interestingly, this would support the model of late fall/winter occupation of hunting camps, but the trend would have to continue in more pits to assert that the sites were only occupied during that one season.

Functionally, hunting camps were expected to have a dearth of high utility elements, while the supported village, SunWatch, was supposed to have mostly high utility elements. There is a general pattern of lower utility at the smaller sites when compared to SunWatch, but high utility elements are still present at these sites suggesting that they were not taking cuts of meat away from the village. There was no statistical correlation between MNI and any measure of meat or marrow utility at neither Wildcat nor Wegerzyn. This lack of correlation indicates that neither site can be considered a functionally-specific hunting camp. Instead, assuming they were year-round sites, they were probably populated by separate groups of Fort Ancient people, not people from SunWatch.

### *Environmental Stress*

Cook et al. (1999, 2004) provided evidence that the years between A.D. 1325 and A.D. 1400 were some of the worst drought years in the past 1,000 years in southwestern Ohio. Two models were considered to account for Fort Ancient reaction to the drought. The first model posited a uniform reaction to the drought at both large and small sites. This model would see any deer herd management techniques abandoned in favor of a "take what we can get" strategy where making the kill was the priority. Selecting for return rate or any other selective behavior

was presumed to be disadvantageous in a time of scarcity. The results of this study strongly support this model.

First, there is a noticeable decline in selectivity at SunWatch over time. In the early period, the age profile based on tooth wear, as well as previous research by Shane (1988), indicates that SunWatch enjoyed a strategy of herd management where they were able to focus on the largest adult deer. This gave them the most meat for their hunting effort. As well, by only occasionally taking juvenile deer, they ensured that there would be a healthy supply of adult deer in the future. The proportion of juvenile bones in the sample from Feature 2/05 (5.15%) also supports the conclusion that young deer were intentionally avoided. The utility pattern for deer in Feature 2/05 also has a healthy deer utilization practice. While it does not strongly correlate with the meat and marrow utility values, the midsection, the shoulder, and the upper hindlimb all have high meat yields and are all well represented in Feature 2/05. All of these measures contrast strongly with the pattern in the later Pit Feature Group 2.1 (Figure 6).

After the drought began, the way in which deer were hunted and utilized at SunWatch changed dramatically. Suddenly, juvenile bones appear more than three times as commonly as before the drought and utility plummets. In fact, SunWatch Pit Feature Group 2.1's very poor utility strongly correlates with the poor utility pattern at Wegerzyn ( $r=0.928$ ).

The food utility index also showed this change through time (Tables 3 and 4). The earlier samples showed a greater use of medium utility elements, indicating that they may have been more selective for utility. In addition to being distinctly different from the early samples, the samples at Wegerzyn and late SunWatch strongly correlate with the food utility pattern of a complete deer. This suggests that, in the later period, people were not as selective or, based on this evidence, not selective at all with regard to food utility. Once again, this falls into the



general paradigm of “take what we can get” in the A.D. 1300s. These data indicate that villages of all sizes were equally susceptible to and equally impacted by the environmental stress caused by increased drought in the 14<sup>th</sup> century.

Based solely on the results presented above showing that both large and small sites were affected equally by the drought, there is no evidence supporting the establishment of a situational heterarchy in the A.D. 1300s to buffer the stress of the drought. Instead, I have shown that smaller sites like Wildcat and Wegerzyn were probably occupied by discrete, autonomous populations, not foragers from SunWatch. It is important to note though, that these results do not imply that a heterarchy (or any other type of relationship) did not exist between SunWatch and its smaller contemporaries. These results only imply that a relationship was not expressed through sharing of deer meat. In fact, it is hard to imagine that smaller villages retained total autonomy in the face of a large, increasingly complex SunWatch village. They may have simply expressed the relationship in a different way. Maize or other crop sharing, if it could be documented, may have been much more vital (and practical) than meat sharing in the effort to survive in the face of drought.

## **Future Research**

On the evidence presented here, the issue of seasonality at smaller sites is far from settled. Other methods, especially paleoethnobotanical and palynological methods, are better suited to identify the particular season that a pit was filled. Additionally, as stated above, seasonality can be examined based on the relative abundances of different animal classes.

The argument for changes in deer selection and utilization over time can be strengthened with the addition of other lines of evidence. Documenting a reduction in body size for white-

tailed deer by using measures of the astragalus (Purdue 1986, 1989) would strengthen the argument that deer populations suffered as a result of the environment. A reduction in body size might also be a proxy indicator for a reduction in plant (including maize) availability during the drought period (Ozoga and Verme 1982).

As is the almost-universal case in archaeology, this study could be improved by the analysis of more sites. By including more sites dated before and during the drought period, one would be able to better establish a trend through time of the abandonment of selective hunting practices. The two time periods used in this study are separated by only around 60-100 years. The nature of radiocarbon dating is such that a date can only be given as a range; sometimes it is a very large range (300+ years). This inhibits the archaeologist's ability to make confident comparisons over short times spans (e.g. the 60-100 years in this study). In this study, we were able to control for this somewhat at SunWatch based on previous analysis of temporally diagnostic artifacts and feature forms associated with each pit feature (see Cook 2007). At Wildcat and Wegerzyn, we have to rely on radiocarbon dates (though in this case their ranges do not overlap).

The relationship between an increasingly complex SunWatch and its neighbors in the A.D. 1300s should be explored to a greater degree. Henderson (1998) used multiple lines of evidence including mortuary practices, village size and plan, and variety in material culture to argue for a heterarchy for Fort Ancient in Kentucky. This same degree of evidence will be required in order to resolve the issue for southwestern Ohio. Additionally, the crop sharing hypothesis needs to be explored as a heterarchical behavior.

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# Appendix

## Results of Identification

SunWatch (early)			Wildcat			Wegerzyn				SunWatch (late)	
	F2/05			F3/07			F1/00	F2/00			FGroup2.1
Element	NISP		Element	NISP		Element	NISP	NISP		Element	NISP
1st Phalanx	15		1st Phalanx	15		1st Phalanx	2	56		1st Phalanx	77
2nd Phalanx	22		2nd Phalanx	6		2nd Phalanx	16	110		2nd Phalanx	44
3rd Phalanx	22		3rd Phalanx	2		3rd Phalanx	5	38		3rd Phalanx	35
Antler	0		Antler	0		Antler	1	5		Antler	0
Astragalus	11		Astragalus	10		Astragalus	9	12		Astragalus	19
Atlas	0		Atlas	0		Atlas	1	9		Atlas	9
Axis	1		Axis	2		Axis	0	12		Axis	3
Calcaneum	11		Calcaneum	5		Calcaneum	1	28		Calcaneum	26
Carpal	17		Carpal	4		Carpal	2	50		Carpal	19
Cervical vert.	8		Cervical vert.	5		Cervical vert.	0	53		Cervical vert.	25
Femur	20		Femur	13		Femur	0	27		Femur	10
Humerus	23		Humerus	10		Humerus	4	37		Humerus	17
Innominate	12		Innominate	3		Innominate	1	18		Innominate	11
Lumbar vert.	7		Lumbar vert.	9		Lumbar vert.	2	63		Lumbar vert.	18
Mandible	10		Mandible	1		Mandible	3	16		Mandible	0
Maxilla	0		Maxilla	1		Maxilla	0	5		Maxilla	8
Metacarpal	5		Metacarpal	2		Metacarpal	0	23		Metacarpal	45
Metapodial	32		Metapodial	20		Metapodial	13	106		Metapodial	16
Metatarsal	11		Metatarsal	19		Metatarsal	2	18		Metatarsal	46
Patella	0		Patella	2		Patella	1	5		Patella	2
Radius	2		Radius	9		Radius	2	23		Radius	19
Rib	94		Rib	27		Rib	3	128		Rib	30
Sacrum	0		Sacrum	1		Sacrum	0	0		Sacrum	1
Scapula	15		Scapula	5		Scapula	9	14		Scapula	25
Skull	0		Skull	1		Skull	0	8		Skull	3
Sternum	1		Sternum	0		Sternum	0	0		Sternum	2
Tarsal	7		Tarsal	4		Tarsal	6	59		Tarsal	26
Thoracic vert.	69		Thoracic vert.	13		Thoracic vert.	0	75		Thoracic vert.	38
Tibia	8		Tibia	9		Tibia	2	35		Tibia	35
Tooth	0		Tooth	3		Tooth	3	11		Tooth	0
Ulna	4		Ulna	1		Ulna	2	14		Ulna	22
<b>Total</b>	<b>427</b>		<b>Total</b>	<b>202</b>		<b>Total</b>	<b>90</b>	<b>1058</b>		<b>Total</b>	<b>631</b>